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N170 Wave Amplitude Analysis on Driving Performance on Highway Road

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***Abstract*— Attention in the physiological definition is taking possession of the mind in one of several simultaneously events of thoughts which implies withdrawing some things to deal effectively with other. In driving particularly, attention is essential to keep track of the driver's vigilance to avoid the road accident. In this paper, analysis of the driver's attention is done through their driving performance from both of Electroencephalographic (EEG) amplitude and accident score. During the driving experiment, two stimulations will be given to the subjects which are silent environment (in certain dB) and listening to the live streaming radio. The results show that when listening to the radio, the driving performance is improved and the score of the accident is reduced as well. This figure gave a concrete justification that driver's attention able to maintain or even increase when the stimulation is triggered.**

***Index Terms*— Attention; Driving Performance; EEG; Accident Score; Stimulation.**

I. INTRODUCTION

According to Malaysian Institute of Road Safety Research (MIROS), a total of 80.6% of the fatal accidents were due to by human error including the speeding, drowsiness, distracted driving and loss of attention [1]. The term of attention here differs from the drowsiness or distracted driving which likely will happen naturally and unexpected. It is the process that occurs so quickly without even notice that the brain ignores certain task in favor of others. This is because the attention itself is limited and selective [2][3]. To stay vigilance during driving is very crucial to avoid the road accident. When the attention is suddenly lost which is called as attention deficit (habituation), the driver might be vigilance but at the same time the mind is not focused on what it should be. A large and growing body of literature of literature has investigated how to confront the issue including eye monitoring, face processing and Event Related Potential (ERP) measurement.

Panos et al. (2010) explored eye movement's monitoring during the day, night and rain routes which identified that during rain, the driver has poor visibility and decrease the effectiveness of driver's visual [4]. This is probably the most factor that causes the road accident especially during night and rain driving. Similarly, Sayani Ghosh (2015) found that real-time eye detection using IR illuminator can avoid the accidents but depends on the lighting conditions [5].

Calder A.J et al. (2012) introduced the N170 component as an electrophysiological marker of face processing [6]. Similarly, Feng W et al. (2012) in their papers proposed that face processing method using spatial attention monitoring [7]. These papers employ the N170 as an electrophysiological marker of face processing to observe the attention condition by giving two different stimuli. The result is significant with the ERP N170 result where the face-specific effect prompted by face in an attended location but no in an unattended one.

Previous research that using ERP as their method is also presented in [8], [9], [10], [11], [12] and [13]. In their paper clearly show the significant results that proof the ERP changes are able to measure the attention either in normal condition or even during driving.

This paper will present the ERP technique which focusing on the N170 wave to observe the driver's performance during driving for attention monitoring purpose. The methodology will be explained in section 2. The result of the experiment will be discussed in section 3. Last but not least, the research finding will be concluded in section 4.

II. METHODOLOGY

A. Participants

A total of sixteen subjects in age between 18 to 25 years with driving license participated in this preliminary experiment. All subjects were students at the Universiti Teknikal Malaysia Melaka and participated on a voluntary basis. The data of nine subjects are excluded due to lack of intelligibility. All subjects signed informed consent prior to taking part in the experiment.

B. Stimuli and Experimental Paradigm

The experiment was conducted on a high fidelity in-lab driving simulator based on virtual reality technology to build the 3D highway driving scene. A 4-channel EEG recording system was applied and attached to the subjects to store the raw EEG data during driving. Concerning the EEG recording setup, The BIOPAC Inc framework (as shown in Figure 1), Mp150 EEG 100c and machine programming (Acknowledge 4.2) is used to record the EEG signal. Surface Electrodes (Ag/Agcl) are set on the occipital lobe. The impedance is guaranteed underneath 5 kΩ. The recorded EEG data was segmented into response extending from 0 to 1s postsimulus. These responses were filtered using a digital filter (bandpass 1-15 Hz). Stimulus ERP was computed by averaging across the subjects for each condition.

Figure 1. BIOPAC Inc. Framework

C. Task and Procedure

The experiment is conducted during daytime in a research lab at Universiti Teknikal Malaysia Melaka. Subjects were seated comfortably in front of the driving simulator as driving the real car. The subjects are required to take the ten minutes training course prior to the experiment in order to get used to the driving simulator. Then, the subjects are given the two different scenarios (with and without listening to the radio) as stimulations during the long monotonous driving around twenty minutes respectively. Apart of it, the sound of 1kHz tone was played throughout the experiment as a time-locked stimulu. Figure 2 shows the procedure conducted during the experiment.

Figure 2. The design setup during driving

III. Result and Discussion

The raw EEG data were acquired continuously during the experiment in real time and written to a file in CSV format in iMac before converting it into the mat file for analysis purpose. The N170 wave is extracted and analyzed using simply averaging method to evaluate the effect to the attention for each subject. The mean from the complex waveform of 500ms of raw EEG data for every 50 responses is calculated to find the average value of N170 wave to show the trends of driving performances. Regression analysis was used to predict the trend and morphology of the graph. Figure 3 and Figure 4 show the individual results (random selection) for both stimulations during driving.

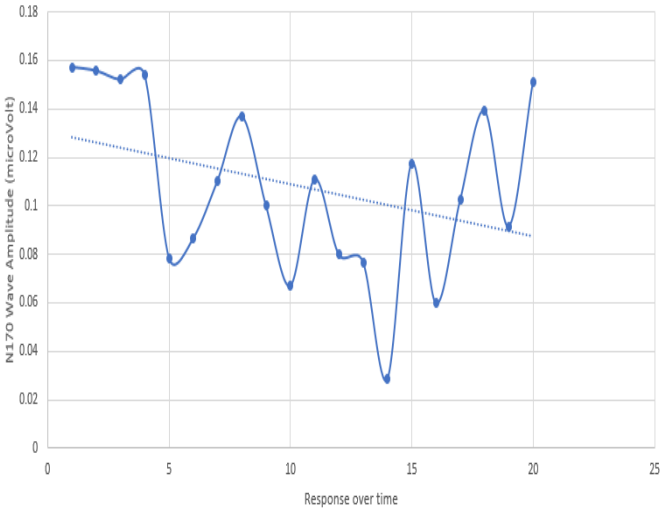

Figure 3. The individual response over the time for no stimulation

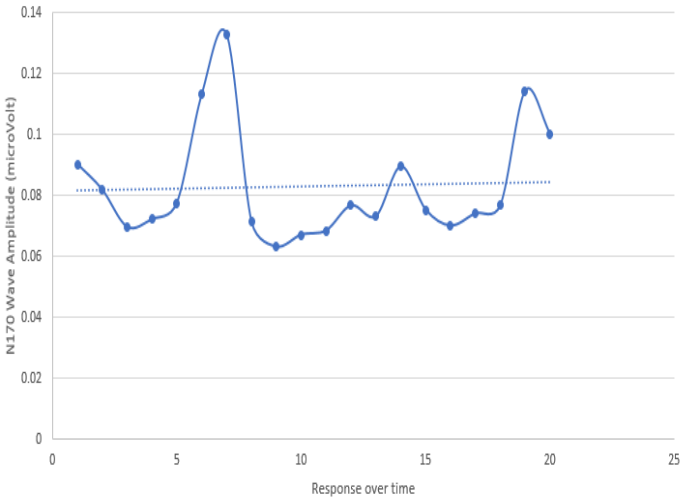

Figure 4. The individual response over the time with stimulation (listening to the radio during driving)

Figure 3 shows that there has been a gradual decline in the value of N170 wave amplitude over the response while Figure 4 reveals slight rise for N170 wave amplitude. It is apparent from these figures that listening to the radio during driving helps to stay maintain or even increase the attention of the subject. Figure 5 and Figure 6 present the average results of N170 wave amplitude for all subjects.

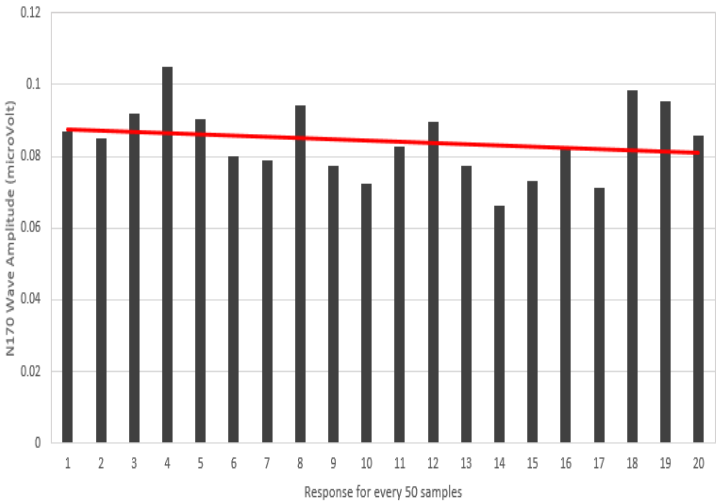

Figure 5. The average of N170 wave amplitude with no stimulation

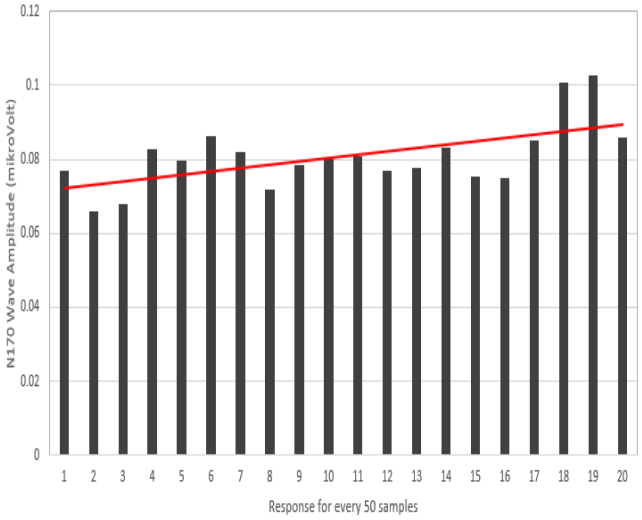

Figure 6. The average of N170 wave amplitude with stimulation

From the result as shown in Figure 5, indicates that there is slightly decrement of N170 wave amplitude over the response which means the driver can be less vigilance when no stimulation triggered during driving. As in Figure 6, it clearly is seen the trend of N170 wave amplitude increasing when listening to the radio during driving. The figure shows the driving performance increases which consistent with the previous research discovered by Jonsson, I.-M. and Dahlback, N. (2014) where their assessment found that the combination of submissive and dominant speech helps driver performance [14]. In terms of percentage, the average difference of last and early experiment, as well as the accident score for both stimulations are presented in Figure 7 and Figure 8.

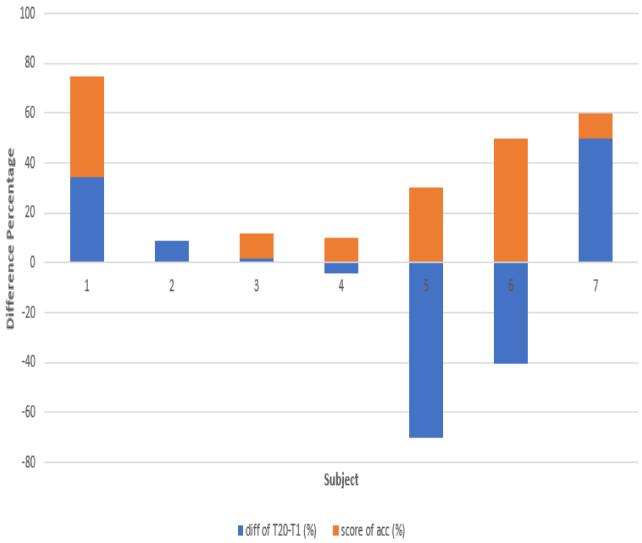

Figure 7. The result of every subject for no stimulation during driving

Both Figure 7 and Figure 8 show the percentage of N170 wave difference as well as the accident score for every subject with both stimulations during driving. The pattern of both figures apparently revealed that when the attention is decreasing (negative value) the possibilities of the accident happen is higher compared to when the attention is an increase (positive value) during driving. However, there is still some number of accident possibilities from the positive values. This is might be the individual difference in terms of how they deal with the secondary task during driving. Previous literature has pointed out that listening to radio might be indeed the strategy to maintain the driving performance [15].

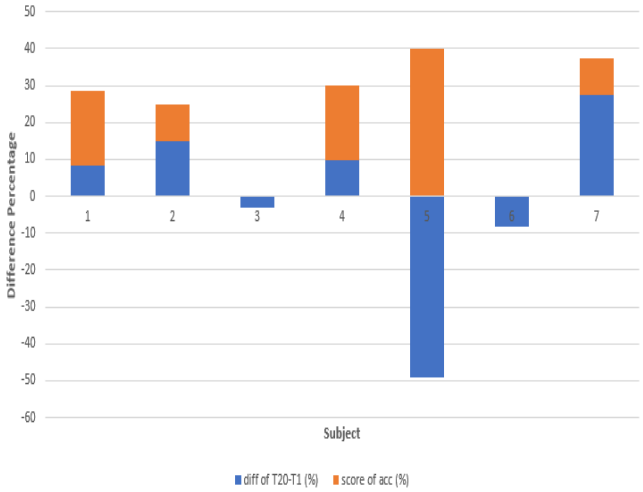

Figure 8. The result of every subject with stimulation during driving

Both Figure 7 and Figure 8 show the percentage of N170 wave difference as well as the accident score for every subject with both stimulations during driving. The pattern of both figures apparently revealed that when the attention is decreasing (negative value) the possibilities of the accident happen is higher compared to when the attention is an increase (positive value) during driving. However, there is still some number of accident possibilities from the positive values. This is might be the individual difference in terms of how they deal with the secondary task during driving. Previous literature has pointed out that listening to radio might be indeed the strategy to maintain the driving performance [15].

IV. CONCLUSION

As it is revealed in the result and discussion section, this paper has shown that in general, listening to the radio while driving enables to maintain or increase the driving performance compared to with those without listening to it (no stimulation). Logically, listening to music is a good distraction to keep the driver's mind on the road. This present study provides additional evidence with respect to keep vigilance during driving (in this case is listening to the radio). However, the sample size (number of participants) were relatively small which means further research needs to be done with more sample of participants to confirm the interpretation of the findings.

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